1 Purpose, Need, and Scope

The U.S. Army Corps of Engineers, Tulsa District is proposing to reallocate storage in Lake Texoma, Oklahoma and Texas, from hydropower storage to water supply storage, pursuant to the Water Resources Development Act of 1986 passed by Congress (Public Law 99-662). The Act authorized the Secretary of the Army to reallocate 150,000 acre-feet each for Oklahoma and Texas for municipal, industrial, and agricultural water uses (a total reallocation of 300,000 acre-feet). The objective of this project is to comply with the intent of Section 838 of Public Law 99-662. The Lake Texoma Water Supply Reallocation Report, which provides information on the reallocation, is attached as Appendix F and is incorporated by reference in this EA. The U. S. Army Hydropower Analysis Center report on power benefits forgone is an appendix to the Reallocation Report.

This project is needed to meet the expanding municipal and industrial water supply demands that are a result of population growth in the region. Denison Dam and Lake Texoma were authorized for construction by the Flood Control Act approved June 28, 1938, (Public Law 75-791) for flood control and generation of hydroelectric power (USACE 2003a). The dam, spillway, and outlet works were started in August 1939 and completed in February 1944. At that time, Denison Dam was America's largest rolled, earth-filled dam. The project was put into operation for flood control in January 1944. The first hydroelectric turbine was placed in operation in March 1945, while a second unit became operational in September 1949. Denison Dam is on the Red River in Bryan County, Oklahoma, and Grayson County, Texas, about 726 miles upstream from the mouth of the river. The dam site is approximately 5 miles northwest of Denison, Texas, and 15 miles southwest of Durant, Oklahoma (Figure 1). Lake Texoma is in Bryan, Marshall, Johnston, and Love counties, Oklahoma; and in Grayson and Cooke counties, Texas (USACE 2003a).

Lake Texoma is now the 12th largest lake in volume in the United States, with a current flood storage capacity of 2,544,830 acre-feet, and hydropower storage capacity of 1,467,283 acre-feet, which includes 150,000 acre-feet for water supply. The main embankment is 15,200 feet long with a maximum height of 165 feet above the streambed (Figure 2). The outlet works consist of three 20-foot diameter concrete conduits through the embankment and six 9-by-19-foot vertical lift gates (Figure 3). The power-intake structure will permit future installation of three additional power units (USACE 2003a, 2003b). Lake Texoma currently provides numerous services to communities in Oklahoma and Texas, including flood control, water supply, hydroelectric power, regulation of Red River flows, improvements to navigation, and recreation resources (USACE 1996a).

The National Environmental Policy Act (NEPA) of 1969 (Public Law 91-190) requires all Federal agencies to address the environmental impacts of any major Federal action on the natural and human environment. Guidance for complying with NEPA is contained in Title 40 of the Code of Federal Regulations (CFR), Parts 1500 through 1508, and in Engineering Regulation 200-2-2, *Procedures for Implementing NEPA*. The primary intent of NEPA is to ensure that as a part of the decision making process, Federal agencies consider the potential environmental consequences of their proposal, document the analysis, and make the information available to the public for comment prior to implementation. This Environmental Assessment (EA) was developed to assure that the proposed storage reallocation project complies with the intent of NEPA.

The Tulsa District issued a news release on August 6, 2003, announcing public information workshops for the Lake Texoma storage reallocation project. Paid display advertisements were published on September 2, 14, and 16, 2003, in the *Denison Herald Democrat*, and September 3, 14, and 17, 2003, in the *Durant Democrat*. The Tulsa District sent scoping and workshop

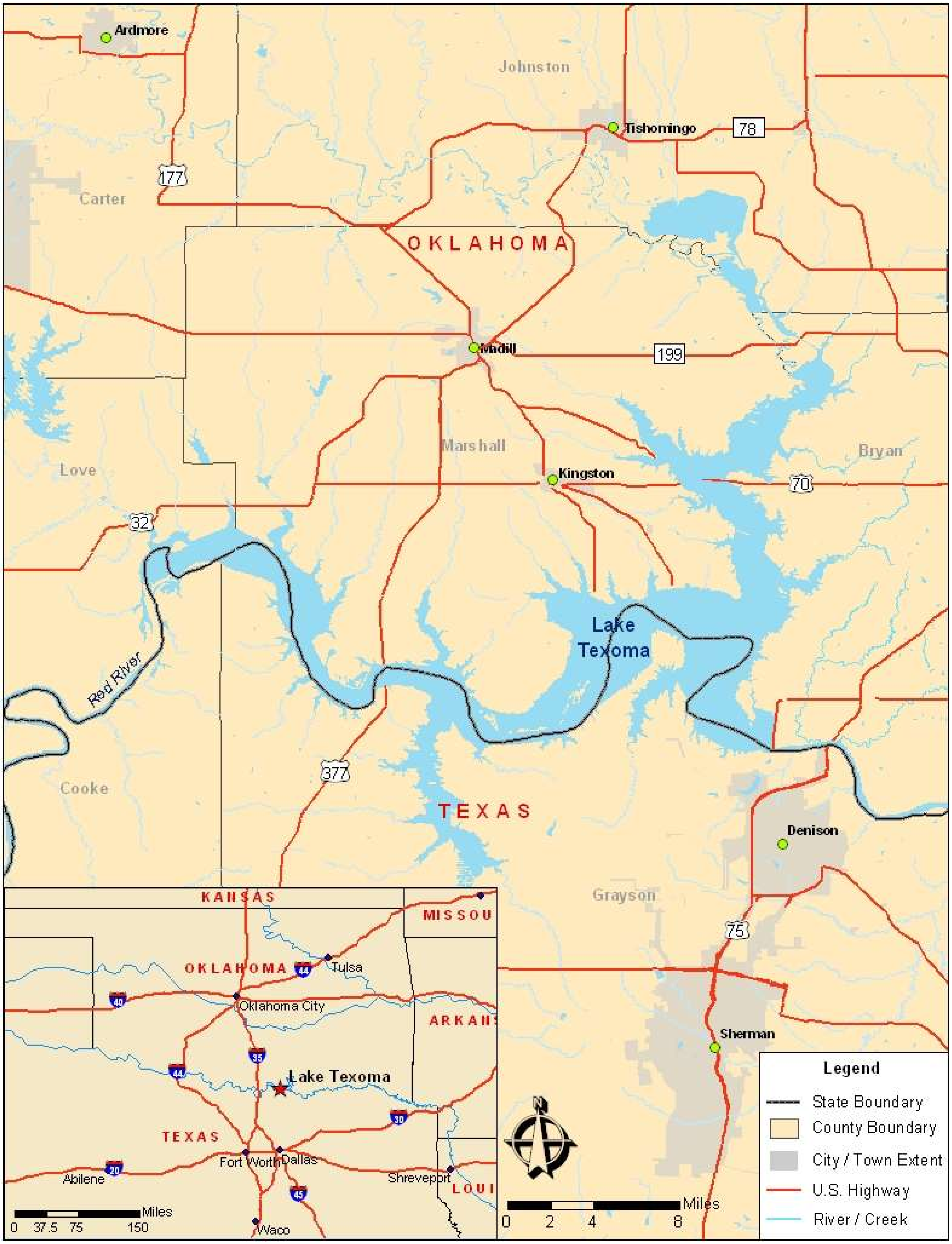

Figure 1. Vicinity Map, Lake Texoma Storage Reallocation Project

Figure 2. Denison Dam and Power Intake Structure

Figure 3. Hydropower Facility and Outlet Works at Denison Dam

announcements to state and Federal resource agencies. The advertisement and the announcements (Appendix A) initiated the NEPA scoping process.

The Tulsa District held workshops on September 16, 2003, (5:00 p.m.–8:00 p.m.) at the Denison Public Library and on September 17, 2003, (5:00 p.m.–8:00 p.m.) at the Durant Chamber of Commerce. Twenty persons attended the workshop including representatives from local, state, and Federal agencies; Native American tribes; congressional delegates; and private citizens. One attendee expressed concern about the striped bass (*Morone saxatilis*) fishery in the lake. Representatives from the Tulsa District explained that the purpose of establishing the seasonal pool in Lake Texoma was to help this fishery. Several attendees expressed concern about the potential for additional pool drawdown and shallow water depths near some of the marinas, docks, and boat ramps. One attendee in favor of reallocation expressed an interest in possibly acquiring future water rights on behalf of his entity, and one attendee opposed to reallocation expressed concern about lower lake levels rendering docks unusable.

2 Alternatives

During plan formulation the goal was to identify and perform an initial evaluation of preliminary alternatives for the reallocation of hydropower storage to water supply at Lake Texoma. Consideration of all reasonable alternatives is required under the National Environmental Policy Act (NEPA) to create a better decision-making process for implementing projects and programs that could adversely impact the environment. The NEPA requires Federal agencies to incorporate environmental considerations in their planning and decision-making process and requires the use of a systematic and interdisciplinary approach. The Planning Guidance Notebook, Engineering Regulation (ER 1105-2-100), dated April 2000, requires the formulation and evaluation of a full range of reasonable alternative plans. Alternative plans are formulated to take into account the overall problems, needs, and opportunities afforded by the proposed action. Those plans are assessed in a manner consistent with the national objective of contributing to National Economic Development (NED) and protecting the Nation's Environment, Federal laws, and regulations. The NED objective is to provide a cost-effective water supply source to meet the region's future municipal and industrial requirements. In this case, the proposed action is the reallocation of Lake Texoma storage from hydropower to water supply.

Economic development problems in the region under existing conditions include insufficient sources of municipal and industrial water at affordable costs to meet future municipal and industrial needs. The reallocation opportunity would provide a source of water supply of sufficient quantity and cost to meet water demands in the near future as the need arises. However, the water available at Lake Texoma for water supply will not meet all the expected future demand for water throughout the region. Other sources of water supply would be required to meet future demands as well. In addition the lower quality of water in Lake Texoma will require blending or additional treatment before it is used for municipal and industrial water supply.

The basis for water supply evaluations in Texas is found in the "Initially Prepared Texas State Water Plan, Region C, 2006", draft version dated June 2005. This report discusses in detail the problems and needs for additional water supply in Region C by water user group, community, and water utility. Future water demands and the availability of existing and potential sources of water supply are presented and evaluated along with water management strategies of major water providers and communities in the North Texas region. These strategies relate to existing and future demand and use of all existing and potential sources of water supply, including Lake Texoma. For Oklahoma, water supply and demand information is taken from studies completed by the Tulsa District for the

Oklahoma Water Resources Board (OWRB) in support of the Oklahoma State Water Plan. This study indicates that existing and potential sources of water supply are available to meet future municipal and industrial needs.

The identified need examined in the 2005 Reallocation Report is the request by the North Texas Municipal Water District (NTMWD) for additional water supply storage of 100,000 acre-feet in Lake Texoma. The letter request is shown as an appendix to the reallocation report. The Greater Texoma Utility Authority (GTUA) also desires reallocated water supply storage. The Water Resource Development Act (WRDA) of 1986 (Public Law 99-662) is the authorization that provides opportunity to address the need and allows the Secretary of the Army the authority to reallocate a total of 300,000 acre-feet of conservation storage to water supply.

The 'Denison Dam-Lake Texoma Restudy, Oklahoma and Texas, feasibility Report', completed by the Corps of Engineers in September 1990, evaluated whether Lake Texoma should be modified to deal with present and projected water resource problems and needs in the region with the focus on increased hydropower production. Although the Restudy focused on increasing hydropower production at Denison Dam, the Restudy is useful in the plan formulation and evaluation of alternative plans regarding changes in the size of the conservation pool and the flood pool.

2.1 No Action Alternative

The Council on Environmental Quality (CEQ) regulations implementing the provisions of NEPA requires Federal agencies to consider a No Action Alternative. These regulations define the No Action Alternative as the continuation of existing conditions and their effects on the environment, without implementation of, or in lieu of, a proposed action. The No Action Alternative represents the existing condition, would not result in any project-related environmental impacts, and serves as the baseline against which to compare the effects of the other alternatives. The Corps considers the option of "No Action" as one of the alternatives in order to comply with the requirements of the NEPA. The No Action alternative is the condition reasonably expected to prevail over the period of analysis, given current conditions and trends, and assuming that no project would be implemented by the Federal government to achieve the planning objectives. The No Action alternative, which is synonymous with the Without-Project Condition, forms the basis from which all other alternative plans are measured. This alternative would not address the intent of Public Law 99-662, Section 838, which authorized the Secretary of the Army to reallocate from hydropower storage to water supply storage, in increments as needed, up to an additional 300,000 acre feet, for municipal, industrial, and agricultural water users in the States of Texas and Oklahoma. The No Action Alternative would not reduce the current need for additional water supply to meet the expanding municipal and industrial water supply demands that are a result of population growth in the region.

Under the No Action Alternative, the storage allocation for all major purposes would be maintained at the current level. The reallocation of 300,000 acre-feet of additional storage from hydropower to water supply would not occur, and the existing allocation of 150,000 acre-feet for water supply would remain. Essentially all of the current water supply storage is being used and North Texas currently is in need of additional water. With the No Action Alternative, this need would not be met. In accordance with Section 4.04 of Article IV of the Red River Compact, division of the flows from the main stem of the Red River into Lake Texoma between the states of Oklahoma and Texas will continue to be in effect.

2.2 Action Alternatives

Potential non-structural solutions include those that would alter the demand for increased water supply in the future. These alternatives would at least partially address some of the problems and needs in the region. The non-structural alternative is to conserve water to reduce the need for additional sources of water supply. Water conservation can include altering the demand for water by water rationing and pricing methods. Communities and major water user groups, such as the NTMWD and the GTUA, already have plans to reduce water consumption as discussed in the "Initially Prepared Region C Texas Water Plan". Water reuse is also a viable non-structural alternative that has been implemented in many areas where permitted. Reuse water in the region is not expected to be more than about 100,000 acre-feet per year by 2060. Those communities and major water utilities that have undertaken steps to reuse water where feasible are shown in the Region C water plan. Where available, reuse water is utilized prior to development of other sources of water supply.

Potential structural and/or operational solutions to the need for additional water supply are:

1. **Change the upper and/or lower limits of the conservation pool to provide additional water supply.** This alternative was evaluated in the 1990 Restudy. Raising the upper limits of the conservation pool would allow higher operating heads for hydropower (when not used for water supply) and higher pool levels for recreation. The need for water supply storage still exists. To address the need for additional water supply, storage would have to be reallocated from hydropower. Recreation was added as a project purpose by the WRDA of 1986. In response to requests to provide a more reliable pool operation for recreation during the high recreation season, a seasonal pool operation was put into effect. Raising both the upper and lower limits of the conservation storage pool would benefit hydropower and water supply and recreation; however, flood control storage would be reduced approximately 46% and existing recreation and wildlife areas around the lake would be adversely impacted. Reduction in flood control storage at Lake Texoma by encroaching on the flood pool would not be acceptable to those in the floodplain downstream of Denison Dam. Although Lake Texoma now controls the 45-year flood event, cumulative flood damages prevented by Lake Texoma is about $178.4 million through Fiscal Year 2004. Raising the lower limits of the conservation pool would restrict hydropower operations and limit water supply although it might be beneficial to recreation users of the lake. The 1990 Restudy also found that enlarging the flood control capability of the existing project was not feasible due to its adverse in-pool impacts on recreation facilities, wildlife, and cultural resources.

2. **New reservoirs above Lake Texoma.** New reservoirs above Lake Texoma on the Red River and the Washita River were evaluated in the 1990 Restudy. Both the Marietta site on the Red River and the Durwood site on the Washita River were found to be not economically feasible for development for flood control operation due to high costs relative to economic benefits and adverse environmental effects. These projects would compensate for loss of flood control storage at Lake Texoma if the upper limits of the conservation pool were increased for hydropower and /or water supply storage.

3. **New groundwater wells.** In some counties in Region C, current use of groundwater exceeds or is near the estimate of long-term reliable groundwater supply. The Region C water plan indicates that water suppliers will need to develop alternate sources of water supply since groundwater resources are overused by temporary over drafting. Some entities in the region rely on groundwater to meet existing and future water needs. These users tend to need smaller quantities of water. However, with large users, the quantity of water available from new groundwater wells would not be sufficient to meet long-term future needs for reliable water supply in the region. Temporary

over drafting of groundwater can be used only as an interim measure until other supplies are developed.

4. **Existing surface water sources.** The Region C water plan, as a guide to utilization of existing sources of water supply, discusses all existing sources of surface water supply currently used and expected to be used in the region to 2060 to meet future water demands. The water management strategy in Region C is to use those sources of supply that are most cost effective and viable alternatives to meet expected municipal and industrial demands. Institutional considerations, such as joint use with other water using entities, also must be taken into account.

5. **New Surface water sources.** The Region C water plan discusses all new sources of surface water supply currently used and expected to be used in the region to 2060 to meet future water demands. In addition, the water management strategy and institutional problems are presented by decade and source of supply for the major water users along with their estimated costs of development. In some cases, several water using entities combine their resources to develop a new source of water supply for a shared use. The reallocation report discusses the water management strategy for the NTMWD and the GTUA regarding existing and new surface sources of water supply.

6. **Downstream Red River Diversion.** The 1990 Restudy addressed pumped storage hydropower facilities at Lake Texoma with an afterbay dam constructed about 7 miles downstream of the existing dam. That study concluded that the afterbay pool would increase the tailwater elevation at the existing units and reduce their efficiency. Construction costs and loss of hydropower efficiency rendered this option not economically feasible. Downstream re-regulation dams and offsite storage would be required with a Red River Diversion. Construction of a downstream dam was considered at the Kiamichi River but was removed from further study because evaporation and seepage would result in losses of up to approximately 25% between there and the Denison Dam. Releases of water from Lake Texoma would have to be increased by the amount lost to evaporation and seepage which would result in a faster drawdown of Lake Texoma. Water quality releases from Hugo Dam into the Kiamichi River could not be withdrawn for water supply without increased releases from Hugo to replace water quality flows. This would result in a faster drawdown of Hugo Lake. Withdrawal of water from the Red River below Denison would require communities located in the upper reaches of Lake Texoma to construct extensive pipeline facilities to transport water greater distances rather than withdrawing water from intake structures located much closer within the lake. Downstream water rights would also be an issue. Downstream Red River Diversions were removed from further study.

The following evaluation matrix displays the screening of preliminary alternatives. The matrix displays potential study alternatives. The alternative of reallocating storage from the existing conservation pool to water supply was found to be the only reasonable alternative. A complete evaluation of alternatives and assumptions used in this analysis can be found in the water supply storage reallocation report which accompanies this EA. This report and its findings are incorporated by reference.

Evaluation Matrix of Preliminary Alternatives.

Alternative	Potential Study Alternatives	Screening Results								Conclusion	Appropriate for Detailed Evaluation
		Meet Future Water Demands	Hydropower Impacts	Environmental Impacts	Flood Control Impacts	Recreation Impacts	Economic Costs	Legislative Direction (WRDA 1986)	Evaluated in Previous Studies		
2	New Reservoirs above Lake Texoma	Yes	None	High	None	None	High	No	Yes	Difficult to justify based on high costs and environmental impacts	No
3	New Groundwater Wells	No	None	None	None	None	High	No	Yes	Production not sufficient to meet high municipal and industrial demands.	No
4	Existing Surface Water Sources	Yes	None	None	None	None	High	No	Yes	Accounted for in Texas State Water Plan, Region C	Yes
5	New Surface Water Sources	Yes	None	Medium	Yes	Yes	High	No	Yes	Accounted for in Region C water management strategy in Texas State Water Plan	Yes
6	Downstream Red River Diversion	Yes	Yes	Medium	None	Yes	High	No	Yes	Economically unfeasible, excessive water loss, extensive pipeline construction, water rights.	No
7	Reallocation from Existing Conservation Pool	Yes	Yes	Low	None	None	Low	Yes	Yes	Legislative mandate to reallocate hydropower storage to water supply storage.	Yes

3 Proposed Action

Under the Proposed Action, pool elevations at Lake Texoma would not be changed. In accordance with the Water Resources Development Act of 1986, 300,000 acre-feet of water currently in hydropower storage would be reallocated to water supply storage, creating a total of 450,000 acre-feet of water supply. The reallocation would provide up to 150,000 additional acre-feet for municipal, industrial, and agricultural water users in the state of Oklahoma and up to 150,000 additional acre-feet for municipal, industrial, and agricultural water users in the state of Texas. This apportionment of the reallocation is consistent with Section 4.04 of Article IV of the Red River Compact, which states that water storage in Lake Texoma, as well as flow from the main stem of the Red River into Lake Texoma, will be divided equally between the states of Oklahoma and Texas.

Water supply at Lake Texoma was not an original project purpose. Several special congressional authorizations have made storage available to users throughout the years. When the Federal government realized that there was an increasing demand for water supply storage, studies were conducted (in 1983 and 1985) to reallocate a total of 150,000 acre-feet of storage from the hydropower purpose to water supply. The cost charged to the user for the storage is based on the highest either of benefits or revenues foregone, replacement costs (as a result of reallocating hydropower storage), or updated cost of storage. The cost of the storage that has been identified as being available for reallocation, but not currently under contract, will continue to increase in value annually until a water storage contract is signed. Storage is not considered to be reallocated from its original purpose until a water storage contract is entered into, and the user starts to pay for and use the storage.

The complete report on power benefits foregone, (Denison Dam & Powerhouse, Lake Texoma, Red River, Oklahoma & Texas, Water Supply Storage Reallocation, Power Benefits Foregone, April 2005 revised), prepared by the U.S. Army Hydropower Analysis Center, is attached to this Environmental Assessment as Appendix G, and is included by reference. In accordance with P. L. 99-662, Section 838 (d)(3), the Southwestern Power Administration shall be provided credits for hydropower lost as a result of the implementation of water supply contracts entered into as a result of this reallocation. The credits shall be of amounts equal to the replacement cost where replacement cost is defined as the cost to purchase power from existing alternative sources. Such credits shall be against sums required to be paid by the Southwestern Power Administration for costs of the project allocated to hydropower. In each such case the Southwestern Power Administration shall reimburse each preference customer for an amount equal to the customer's actual replacement cost for hydropower lost as a result of implementation of such contract, less the cost such customer would have had to pay to the Southwestern Power Administration for such hydropower.

Power benefits foregone, which are equivalent to replacement costs of power, and power revenues foregone were considered over a 50-year evaluation period in order to determine the cost of the storage reallocation being requested. The non-power related updated cost of storage was not evaluated in the benefits foregone report. The reallocation cost to the water supply customers will be the highest cost for each of these different components.

Data was developed summarizing power benefits foregone for 300,000 AF and for 450,000 AF as shown in Table 1. The replacement cost of power as used in determining the cost of the reallocation to the water supply customer is identical in each case to the hydropower benefits foregone. Summarizing the data developed in the benefits foregone report, the power revenues foregone are in Table 2 and the estimated SWPA credits are in Table 3.

Table 1: Annual Power Benefits Foregone

Allocation Alternative	300,000 AF	450,000 AF
Annual Energy Benefit Foregone	$398,600	$790,600
Capacity Benefit Foregone	$258,300	$611,800
Annual Benefit Foregone	**$656,900**	**$1,402,400**

Table 2: Annual Revenue Foregone

Allocation Alternative	300,000 AF	450,000 AF
Annual Energy Revenue Foregone	$99,000	$196,300
Capacity Revenue Foregone	$299,400	$664,700
Annual Revenue Foregone	**$398,400**	**$861,000**

Table 3: Annual SWPA Credit

Allocation Alternative	300,000 AF	450,000 AF
Energy Credit	$240,500	$477,800
Capacity Credit	$280,000	$642,400
Annual Credit to PMA	**$520,500**	**$1,120,200**

4 Affected Environment

4.1 Location

The Lake Texoma project study area consists of the main body of the lake as well as the various arms created by the Denison Dam. The lake is on the Red River between Texas and Oklahoma, approximately 5 miles north of Denison, Texas (see Figure 1). As mentioned previously, the lake spans numerous counties in both states, including Bryan, Marshall, Johnston, and Love counties, Oklahoma; and Grayson and Cooke counties, Texas. Lake Texoma receives water from the drainage area of the Washita and Red Rivers (approximately 39,719 square miles) (USACE 2003a).

4.2 Climate

Data in the region indicate that the climate in the project area is typified by long, hot summers and relatively short, mild winters. The average summer (June, July, and August) temperature for the Oklahoma counties of Bryan, Marshall, Johnston, and Love is 80.6 degrees Fahrenheit (°F). The average winter (December, January, and February) temperature is 42 °F. Average annual precipitation in these counties is about 43 inches, with an average of 27 inches usually falling during the period of April through October. As a result of squall-line thunderstorms, rains occur most frequently in the late spring with peak rainfall amounts in May. Average seasonal snowfall is 0 to 6 inches (OCS 2002).

The average summer temperature in the vicinity of Cooke and Grayson Counties, Texas is 80 °F, while the average winter temperature is 46.6 °F. Average annual precipitation in the vicinity of these counties is about 35.2 inches, with an average of 23 inches falling during the period of April through October. Peak rainfall amounts occur in May, and the average seasonal snowfall is 0.55 inches (NCDC 2002).

The prevailing winds in the vicinity of Lake Texoma (as recorded in Sherman, Texas, approximately 15 miles south of Denison Dam) are from the south-southeast (NCDC 1998).

4.3 Socioeconomics

4.3.1 Study Area

Lake Texoma is within several Oklahoma and Texas counties. The primary communities in the vicinity of Lake Texoma are Denison, Texas, (approximately 5 miles south) and Durant, Oklahoma (approximately 15 miles north). The city of Durant and counties of Bryan, Marshall, Johnston, and Love, Oklahoma; and the city of Denison and the counties of Grayson and Cooke, Texas, are considered the social area where project-related impacts could occur.

4.3.2 Population

Tables 4 and 5 summarize population data from the 2000 Census for the communities and counties in the social area that could be affected by the proposed storage reallocation project at Lake Texoma.

Table 4. Area Population: City of Durant; Bryan, Marshall, Johnston, and Love Counties; and the State of Oklahoma

	Census 1990 Population	Census 2000 Population	Percent Growth
City of Durant	12,823	13,549	5.6%
Bryan County	32,089	36,534	13.9%
Marshall County	10,829	13,184	21.7%
Johnston County	10,032	10,513	4.8%
Love County	8,157	8,831	13.4%
State of Oklahoma	3,145,585	3,450,654	9.7%

Sources: U.S. Census Bureau 2003, 2004

Table 5. Area Population: City of Denison; Grayson, and Cooke Counties; and the State of Texas

	Census 1990 Population	Census 2000 Population	Percent Growth
City of Denison	21,505	22,773	5.9%
Grayson County	95,021	110,595	16.4%
Cooke County	30,777	36,363	18.1%
State of Texas	16,986,510	20,851,820	22.8%

Sources: U.S. Census Bureau 2003, 2004

4.3.3 Employment and Income

In 2000, there were 252,342 people in the social area for the Lake Texoma storage reallocation project. The majority of the workers in the social area are employed in the educational, health, and social services; manufacturing; and retail trade sectors. As petroleum is found extensively in the vicinity of Lake Texoma, oil and gas pumping plants, refineries, foundries, and associated industries for the processing of petroleum products are of major importance in northern Texas and portions of southern Oklahoma (USACE 1993a). Tables 6 and 7 present employment and income information for the social area.

4.3.4 Social Ecology

The social area contains a mix of residential areas; agriculture and livestock raising; retail, commercial, and concession operations, many of which provide recreation-related services (e.g., marinas, gas stations, lodging, restaurants, boat rentals, picnic areas) to lake users; and industrial activities. The growing communities of Durant, Oklahoma, and Denison, Texas, serve as centers for retail and service businesses, while Lake Texoma is a major recreation destination, especially for the residents of North Texas.

Table 6. Employment and Income: City of Durant; Bryan, Marshall, Johnston, and Love Counties; and the State of Oklahoma

	Census 2000 Per Capita Income[1]	Census 2000 Median Household Income[1]	July 2004 Unemployment Rate
City of Durant	$13,849	$25,328	3.2%[2]
Bryan County	$14,217	$27,888	3.2%[3]
Marshall County	$14,982	$26,437	4.6%[3]
Johnston County	$13,747	$24,592	5.0%[3]
Love County	$16,648	$32,558	5.2%[3]
State of Oklahoma	$17,646	$33,400	4.4%[3]

Sources: [1]U.S. Census Bureau 2004, [2]OKDOC 2004, [3]ORIGINS 2004

Table 7. Employment and Income: City of Denison; Cooke and Grayson Counties; and the State of Texas

	Census 2000 Per Capita Income[1]	Census 2000 Median Household Income[1]	August 2004 Unemployment Rate[2]
City of Denison	$17,685	$31,474	6.3%
Grayson County	$18,862	$37,178	5.6%
Cooke County	$17,889	$37,649	4.2%
State of Texas	$19,617	$39,927	5.8%

Sources: [1]U.S. Census Bureau 2004, [2]TWC 2004

4.4 Natural Resources

4.4.1 Terrestrial

The topography surrounding Lake Texoma varies from gently sloping flats to rocky and precipitous cliffs to steep, wooded hillsides (Figure 4). The terrain in the vicinity of the lake varies in elevation from about 850 feet above mean sea level (MSL) in Marshall County, Oklahoma, to approximately 500 feet above MSL at the base of the dam (USACE 1989, 2003a). The formation of the lake has influenced vegetation and habitat, creating shoreline environments that did not exist prior to filling the reservoir, and eliminating floodplain and riparian habitat that was supported along the Red River in this area.

The project area is located in the Prairie Parkland (Subtropical) Province of the Prairie Division (Bailey 1995). Lake Texoma is in a transitional zone between the Eastern Oak Forest and the Tallgrass Prairie. There are four basic vegetative types identified around the lake: marsh, bottomland forest, post oak-blackjack oak (*Quercus stellata*-*Q. marilandica*) forest, and tallgrass prairie (USACE 2003a). Marshes are areas generally inundated with water long enough to support emergent wetland vegetation. At Hagerman National Wildlife Refuge on the south side of Lake Texoma, marshes support vegetation such as wild millet (*Pennisetum americanum*), sedges (*Carex* spp.), and smartweed (*Polygonum* spp.) (USFWS 2004).

Radiating out from the shoreline to higher, better-drained sites, the vegetation community progresses from subclimax to climax bottomland forests. The mesic shoreline environment is dominated by vegetation including black and sandbar willow (*Salix nigra* and *S. exigua*), buttonbush (*Cephalanthus occidentalis*), and the exotic tamarisk (*Tamarix* spp.). The subclimax bottomland forest extending outward from the edge of the lake supports cottonwoods (*Populus* spp.), sycamore (*Platanus occidentalis*), and willows (USACE 1989).

The climax bottomlands around Lake Texoma are composed of a variety of large mature trees, including pecan (*Carya illinoensis*), black walnut (*Juglans nigra*), hackberry (*Celtis* spp.), green ash (*Fraxinus pennsylvanica*), American elm (*Ulmus americana*), red oak (*Q. rubra*), and black oak (*Q.*

Figure 4. Shoreline Topography and Vegetation of Lake Texoma

velutina). None of these species are dominant in the overstory, and are distributed variably throughout this climax bottomland forest community (USACE 1989).

The post oak-blackjack oak forests are found in upland areas around the lake. Other tree species found in this plant community include shumard oak (*Q. shumardii*), chinquapin oak (*Q. muehlenbergii*), black hickory (*Carya texana*), American elm, and eastern red cedar (*Juniperus virginiana*) (USACE 1989, 1996b).

Beyond these oak forests surrounding Lake Texoma is a tallgrass prairie plant community. The grasslands within the boundaries of the Lake Texoma project are managed by the Tulsa District primarily for grazing. King Ranch bluestem (*Bothriochloa ischaemum*) and Bermuda grass (*Cynodon dactylon*) have been planted in some of these areas to improve pasture conditions. The predominant native grasses supported in the tallgrass prairie community include big bluestem (*Andropogon* *gerardii*), Indian grass (*Sorghastrum nutans*), and switchgrass (*Panicum virgatum*). In many places, this prairie community is being invaded by grasses and forbs characteristic of overgrazed or disturbed sites (USACE 1989).

4.4.2 Soils and Prime Farmland

Soils of the Lake Texoma storage reallocation project area are generally nearly level to sloping, loamy and clayey soils. Approximately 25 soil associations have been identified in the vicinity of Lake Texoma. These associations are listed and briefly described in Table 8.

Table 8. Soil Associations in the Vicinity of Lake Texoma

Soil Association	Description
OKLAHOMA[1]	
BRYAN COUNTY	
Muskogee-Boxville	Deep, nearly level to sloping, moderately well-drained or well-drained, loamy soils that have a loamy or clayey subsoil. Found on uplands. Makes up about 16 percent of soils in Bryan County.
Bernow-Romia	Deep, strongly sloping to moderately steep, well-drained, sandy or loamy soils that have a loamy subsoil. Found on uplands. Makes up about 11 percent of soils in Bryan County
JOHNSTON COUNTY	
Verdigris-Gracemont-Oklared	Deep, nearly level or very gently sloping, well-drained to somewhat poorly drained, loamy or sandy soils that have a loamy subsoil. Found on floodplains. Makes up about 8 percent of soils in Johnston County
Konawa-Dougherty	Deep, nearly level or very gently sloping, well-drained, loamy or sandy soils that have a loamy subsoil. Found on uplands. Makes up about 4 percent of soils in Johnston County.
Gasil-Stephenville	Deep or moderately deep, very gently sloping to strongly sloping, well-drained loam soils that have a loamy subsoil. Found on uplands. Makes up about 21 percent of soils in Johnston County.
Burleson-Durant-Ferris	Deep, nearly level to strongly sloping, moderately well-drained or well-drained, clayey or loamy soils that have a clayey subsoil. Found on uplands. Makes up about 18 percent of the soils in Johnston County.
LOVE COUNTY	
Dougherty-Eufaula	Deep, nearly level to gently rolling, well-drained, sandy soils that have a loamy subsoil. Found on uplands. Makes up about 23 percent of soils in Love County.
Teller-Minco	Deep, nearly level to moderately sloping, well-drained, loamy soils that have a loamy subsoil. Found on uplands. Makes up approximately 9 percent of the soils in Love County.
Windthorst-Stephenville	Deep, nearly level and gently rolling, well-drained loamy soils that have clayey or loamy subsoils. Found on uplands. Makes up approximately 34 percent of soils in Love County.

Table 8. Soil Associations in the Vicinity of Lake Texoma (cont'd)

Soil Association	Description
Miller-Yahola	Deep, nearly level, moderately well-drained to well-drained, clayey and loamy soils that have clayey and loamy subsoils. Found on bottomlands along the Red River. Makes up about 3 percent of soils in Love County.
San Saba-Durant	Deep, gently sloping to rolling, moderately well-drained, clayey soils that have clayey subsoils. Found on uplands. Makes up about 18 percent of soils in Love County
MARSHALL COUNTY	
Bastrop-Konawa	Deep, nearly level to sloping, well-drained soils with a loamy surface layer and loamy subsoil. Found on terraces along the Red River, Washita River, and some major streams. Makes up about 10 percent of the soils in Marshall County.
Dougherty-Konawa	Deep, nearly level to sloping, well-drained soils with a sandy and loamy surface layer and loamy subsoils. Found on terraces along the Red River and some major streams. Makes up about 8 percent of soils in Marshall County.
Ferris-Tarrant-Heiden	Deep and shallow, very gently sloping to moderately steep, well-drained soils that are clayey or cobbly and clayey throughout. Found on uplands. Makes up about 42 percent of soils in Marshall County.
Durant-Collinsville	Deep and shallow, very gently sloping to strongly sloping, moderately well-drained and somewhat excessively drained soils with a loamy surface layer and loamy and clayey subsoils. Found on uplands. Makes up about 17 percent of soils in Marshall County.
Frioton-Gracemont	Deep, nearly level, well-drained and somewhat poorly drained soils with a loamy surface layer over loamy sediments. Found on floodplains. Makes up about 3 percent of soils in Marshall County.
Konsil-Madill	Deep, nearly level to moderately steep, well-drained soils with a loamy surface layer and a loamy subsoil (on uplands), and a loamy surface layer over loamy sediments (on floodplains). Found on uplands and floodplains. Makes up about 18 percent of soils in Marshall County.
TEXAS[2]	
COOKE COUNTY	
Sanger-Slidell-San Saba	Deep and moderately deep, nearly level to sloping, well-drained, clayey soils that have clayey subsoils. Found on uplands. Makes up about 20 percent of soils in Cooke County.

Table 8. Soil Associations in the Vicinity of Lake Texoma (cont'd)

Soil Association	Description
Gaddy-Teller-Miller	Deep, nearly level, well-drained to somewhat excessively drained, loamy sands, and clayey soils that have sandy loam and clayey subsoils. Found on bottomlands and terraces. Makes up about 4 percent of soils in Cooke County.
Sanger-Maloterre-Venus	Deep and very shallow, gently undulating to hilly, well-drained to somewhat excessively drained, clayey and loamy soils that have loamy and clayey subsoils. Found on uplands and terraces. Makes up about 14 percent of soils in Cooke County.
GRAYSON COUNTY	
Normangee-Crockett-Wilson	Deep, nearly level to sloping, very slowly permeable loamy soils with clayey subsoils. Found on ridges and side slopes of uplands. Makes up about 27 percent of soils in Grayson County.
Sanger-Bolar	Deep and moderately deep, gently to strongly sloping, very slowly permeable to moderately permeable, clayey and loamy soils with clayey subsoils. Found on ridges and side slopes of uplands. Makes up about 2 percent of soils in Grayson County.
Callisburg-Crosstell-Gasil	Deep, gently sloping to sloping, moderately permeable to very slowly permeable, loamy and sandy soils that have clayey subsoils. Found on uplands. Makes up about 16 percent of soils in Grayson County.
Aubrey	Moderately deep, gently to strongly sloping, slowly permeable, loamy soils with sandy, loamy, and clayey subsoils. Found on ridgetops and on convex, strongly sloping, upper side slopes of ridges. Makes up about 2 percent of soils in Grayson County.
Bastrop-Okay-Oklared	Deep, nearly level to gently sloping, moderately permeable and moderately rapidly permeable, loamy soils with sandy, loamy, and clayey subsoils. Found on terraces. Makes up about 2 percent of soils in Grayson County.

[1]USDA 1977, 1978a, 1978b, and 1980b
[2]USDA 1979, 1980a

Soil that is prime or unique farmland as defined in the Farmland Protection Policy Act (7 United States Code [U.S.C.] 4201–4209) is classified as prime farmland. According to the U.S. Department of Agriculture, prime farmland soil is soil that is best suited for producing food, feed, forage, fiber, and oilseed crops. Those soils that could occur in the associations noted above and that have been classified as prime farmland are listed in Table 9.

4.4.3 Hydrology

Lake Texoma, formed by Denison Dam on the Red River, receives water from the drainage area (approximately 39,719 square miles) of the Red River and the Washita River, its main tributary upstream of the dam. The Red River arm of the lake is about 60 miles long and the Washita River arm is about 45 miles long. The gradient of the Red River is approximately 1.6 feet per mile for the entire length of Lake Texoma, while the channel capacity is approximately 45,000 cubic feet per

Table 9. Prime Farmland in the Vicinity of Lake Texoma

County, State	Soil Series
Bryan County, OK	Bernow, Boxville, Dennis, Durant, Freestone, Karma, Madill, Muskogee, Okay
Johnston County, OK	Burleson, Dale, Dela, Dennis, Durant, Frioton, Gasil, Gowton, Heiden, Kaufman, Konawa, Lula, Oklared, Ravia, Steedman, Stephenville, Verdigris
Love County, OK	Brewer-Vanoss Complex, Durant, Minco, Pulaski, Teller, Vanoss, Windthorst, Yahola
Marshall County, OK	Bastrop, Burleson, Counts, Durant, Frioton, Heiden, Konawa, Konsil, Madill, Teller
Cooke County, TX	Bolar, Miller, Minco, San Saba-Slidell Complex, Slidell, Slidell-San Saba Complex, Teller, Venus, Yahola
Grayson County, TX	Bastrop, Bolar, Callisburg, Gasil, Okay, Oklared, Sanger

Source: USDA 2000a, 2000b, 2000c, 2002, 2004

second (cfs) downstream of Denison Dam (Figure 5). From Denison Dam to Fulton, Arkansas, the river flows between high banks about 1,000 feet apart (USACE 1989, 1993a, and 2003a). Releases from the dam are adequate to provide minimum and surge flows that help support the aquatic habitat and wetlands downstream of Lake Texoma.

At normal pool, the lake encompasses more than 89,000 surface acres, which can increase to 143,000 acres at the top of the flood control pool, and more than 580 miles of shoreline. Water storage (for hydropower, water supply, and flood control purposes) occurs between 590 and 640 feet above MSL. A seasonal pool plan has been implemented at Lake Texoma to enhance recreational opportunities. The plan includes the following (USACE 1993a):

- Drawdown of lake levels to 615 feet above MSL in the late winter and early spring
- Rise to 619 feet above MSL during May and through the summer
- Drawdown to 616.5 feet above MSL in the late summer and early fall
- Rise to 618.5 feet above MSL in late fall and early winter

Table 10 provides the elevations and storage capacity for the pools at Lake Texoma.

The lake inflow carries a large amount of sediment that mostly comes from the Red River. During periods of high flow, bank caving and erosion occur at many locations upstream of Lake Texoma, increasing the sediment load in the lake, and decreasing water storage capacity (USACE 1993a). Recently, a sediment study was completed by the Texas Water Development Board, which compared the total volume of water storage available in Lake Texoma from the original design in 1942 with the results of studies conducted in 1969, 1985, and 2002 (TWDB 2003). Table 11 summarizes the results, and illustrates the decrease in water storage capacity in the lake.

Figure 5. Red River Immediately Downstream of Lake Texoma and Denison Dam

Table 10. Water Storage Data for Lake Texoma and Denison Dam

Feature	Elevation (feet)	Reservoir Area (acres)	Reservoir Capacity (acre-feet)[1]
Top of Dam	670	--	--
Top of Flood Control Pool	640	141,418	5,061,062
Flood Control Storage	617 to 640	--	2,544,830
Top of Power Pool	617	74,686	2,516,232
Conservation Storage	590 to 617	--	1,467,283[2]
Bottom of Power Pool	590	--	1,048,949

Source: USACE 2003a

Notes: [1]Includes dead storage in the Cumberland Pool.
[2]Includes 150,000 acre-feet of water supply storage.

Models using projected future sedimentation to the year 2044 (the end of the project life at Lake Texoma) have been run to estimate future water supply availability, assuming full use of the 150,000 acre-feet of existing water supply storage at Lake Texoma. The results of this modeling, which are presented in Appendix B, indicate that future water supply yield would be 228.4 cfs.

Table 11. Comparison of Water Storage Capacity at Lake Texoma (1942–2002)

	1942[1]	1969	1985	2002
Total Volume (ac-ft)	3,132,293	2,688,411	2,580,389	2,516,232
Total Storage Lost (ac-ft) from Original Design	--	443,882	551,904	616,061
Total Storage Lost (%)	--	14.2%	17.6%	19.7%

Source: TWDB 2003
Note: [1]Original design

Appendix B also provides the results of modeling performed by the Tulsa District to determine baseline elevation duration (percent of time a particular lake level was equaled or exceeded), elevation frequency (percent of years a particular lake level was equaled or exceeded), discharge duration (percent of time a particular discharge was equaled or exceeded), discharge duration (percent of years a particular discharge was equaled or exceeded), and discharge frequency (percent of years a particular lake level was equaled or exceeded) at Lake Texoma for the period of 1938 to 2000. Discharge duration and discharge frequency model results are also presented for Arthur City, Texas, downstream of Lake Texoma.

In 1972, amendments to the Clean Water Act (CWA), specifically the establishment of Section 303(d), required states to develop lists of water bodies that do not meet water quality standards and to submit updated lists to the U.S. Environmental Protection Agency (USEPA) every 2 years. USEPA is required to review impaired water body lists submitted by each state and approve or disapprove all or part of the list (OKDEQ 2003).

For water bodies on the 303(d) list, the CWA requires that a pollutant load reduction plan or total maximum daily load (TMDL) be developed to correct each impairment. TMDLs must document the nature of the water quality impairment, determine the maximum amount of a pollutant load which can be discharged and still meet standards, and identify allowable loads from the contributing sources. The elements of a TMDL include a problem statement, description of the desired future condition (numeric target), pollutant source analysis, load allocations, description of how allocations relate to meeting targets, and margin of safety (OKDEQ 2003).

The states of Oklahoma and Texas have yet to develop TMDLs for waters of the Red River, Washita River, or Lake Texoma. The Oklahoma Department of Environmental Quality (OKDEQ) has identified several river segments in the Red and Washita river drainages, as well as the Upper Washita River Arm of Lake Texoma, on their 2002 303(d) list submitted to and approved by USEPA. The Upper Washita River Arm of the lake has been listed due to nonattainment with the warm water aquatic community beneficial use designation (OKDEQ 2002). OKDEQ has listed 2005 as its targeted date for development of TMDLs for all listed segments of the Red River, as well as the Upper Washita River Arm of Lake Texoma. TMDL development is scheduled for 2004 (three segments), 2005 (three segments), and 2009 (four segments) for the Washita River segments on the 303(d) list (OKDEQ 2002).

The Texas Commission on Environmental Quality (TCEQ) released a draft 303(d) list for 2004 on January 15, 2004. This list does not identify any waters of Lake Texoma or the Red River. However, the Upper Prairie Dog Town Fork of the Red River is on the draft 2004 303(d) list for Texas. More data and information are needed before the TCEQ will schedule the development of a TMDL for this segment (TNRCC 2004).

The National Wetlands Inventory of the U.S. Fish and Wildlife Service classified the majority of wetlands in the vicinity of Lake Texoma in the palustrine system; however, wetlands classified in the lacustrine and riverine systems are also present (USFWS 2004). Wetlands classified as palustrine are nontidal and are dominated by trees, shrubs, emergents, mosses, or lichens. Within these three systems (palustrine, lacustrine, and riverine), wetlands have been further classified as limnetic and littoral (lacustrine); emergent, forested, scrub-shrub, unconsolidated bottom, and unconsolidated shore (palustrine); and lower perennial (riverine). Many of the wetland types have been further classified as diked/impounded or excavated, indicating that they formed under conditions created by humans. The wetlands in the vicinity of Lake Texoma are also subject to different hydrologic regimes, including seasonally flooded, semipermanently flooded, and permanently flooded.

Dominant vegetation found in wetlands of the Tishomingo and Hagerman National Wildlife Refuges, which are adjacent to Lake Texoma, include boxelder (*Acer negundo*), black willow (*Salix nigra* var. *lindheimeri*), cottonwood, sedges, saltgrass (*Distichlis* spp.), native millet (*Panicum miliaceum*), pondweed (*Potamogeton nodosus*), smartweed, arrowleaf *(Sagitaria* spp.), cattail (*Typha* spp.), rushes (*Juncus* spp.), and bulrush (*Scirpus pendulus*). Wetlands provide essential habitat for waterfowl as well as shore birds, wading birds, and several mammal and reptile species (USFWS 2000a, 2000b).

4.4.4 Wild and Scenic Rivers

There are no streams or rivers within the project area that are classified as wild and scenic pursuant to the Federal Wild and Scenic Rivers Act (Public Law 90-542).

4.4.5 Fish and Wildlife

The aquatic, wetland, and upland habitats at Lake Texoma support a diversity of fish and wildlife. The Oklahoma Department of Wildlife Conservation (ODWC) and the Texas Parks and Wildlife Department (TPWD) have the responsibility to manage, regulate, and control fish and wildlife resources for Lake Texoma. There is a cooperative agreement with the U.S. Fish and Wildlife Service to preserve and improve wildlife habitat for the 13,450 acres in Tishomingo National Wildlife Refuge and 11,400 acres in Hagerman National Wildlife Refuge (USACE 2003a). The following four subsections provide a listing of fish and wildlife species that could occur at Lake Texoma.

4.4.5.1 Fish

Management of the fishery resources at Lake Texoma is the responsibility of the ODWC and TPWD. Lake Texoma provides habitat for at least 70 species of fish, several of which were introduced by the ODWC and TPWD (USACE 2003). These agencies maintain a supplemental stocking program to improve the fishery resource. Those species popular for recreational fishing include channel (*Ictalurus punctatus*), blue (*I. furcatus*), and flathead catfish (*Pylodictis olivaris*); largemouth (*Micropterus salmoides*), spotted (*M. punctulatus*), white (*Morone chrysops*), smallmouth (*Micropterus dolomieui*) and striped bass; and white crappie (*Pomoxis annularis*). The smallmouth bass is increasing in abundance and popularity and Lake Texoma has held the past five Oklahoma smallmouth bass state records since 1988. The striped bass fishery at Lake Texoma is extremely popular and is considered one of the most successful striped bass fisheries in the nation. In addition, downstream of the dam is a tailwater fishery that supports striped bass, as well as channel, blue, and flathead catfish. The spawning of striped bass in the Red and Washita rivers is the key to the continued success of this sport fishery (USACE 1989).

Gizzard shad (*Dorosoma cepedianum*), threadfin shad (*D. petenense*), and Mississippi silverside (*Menidia audens*) are considered important forage species in the lake. Freshwater drum (*Aplodinotus* *grunniens*), carp (*Cyprinus carpio*), gar (*Lepisosteus* spp.), buffalo (*Ictiobus* spp.), and river carpsucker (*Carpiodes carpio*) make up the bulk of rough fishes in the lake (USACE 1989).

4.4.5.2 Amphibians and Reptiles

Numerous amphibians and reptiles are known to occur at Lake Texoma. Species of amphibians that are supported include salamander (*Ambystoma* spp.), plains and eastern spadefoot toad (*Scaphiopus bombifrons* and *S. holbrookii*, respectively), gray tree frog (*Hyla versicolor*), chorus frog (*Pseudacris* spp.), bullfrog (*Rana catesbeiana*), and the southern leopard frog (*R. pipiens*). Reptile species at Lake Texoma include snapping turtle (*Chelydra sepentina*), box turtle (*Terrapene* spp.), eastern fence lizard (*Sceloporus undulatus*), Texas horned lizard (*Phrynosoma cornutum*), water snake (*Natrix* spp.), Texas brown snake (*Storeria dekayi*), common garter snake (*Thamnophis sirtalis*), eastern hognose snake (*Heterodon platyrhinos*), black rat snake (*Elaphe obsoleta*), copperhead (*Agkistrodon contortrix*), western diamondback rattlesnake (*Crotalus atrox*), and the western pigmy rattlesnake (*Sistrurus miliarius*) (USACE 2003a).

4.4.5.3 Birds

The variety of habitats at Lake Texoma support numerous species of migratory waterfowl and wading birds, upland game birds, raptors, and songbirds. These include mallards (*Anas platyrhynchos*), Canada goose (*Branta canadensis*), blue-winged teal (*A. discors*), pintail (*A. acuta*), great blue heron (*Ardea herodias*), little blue heron (*Florida caerulea*), turkey (*Meleagris gallopavo*), northern bobwhite (*Colinus virginianus*), red-tailed hawk (*Buteo jamaicensis*), turkey vulture (*Cathartes aura*), crows (*Corvus brachyrhynchos*), killdeer (*Charadrius vociferous*), yellow-billed cuckoo (*Coccyzus americanus*), red-bellied woodpecker (*Centurus carolinus*), purple martin (*Progne subis*), barn swallow (*Hirundo rustico*), Carolina chickadee (*Parus carolinensis*), tufted titmouse (*P. bicolor*), Eastern bluebird (*Sialia sialis*), Northern mockingbird (*Mimus polyglottos*), European starling (*Sturnus vulgaris*), lark sparrow (*Chondestes grammacus*), Northern cardinal (*Richmondena cardinalis*), painted bunting (*Passerina ciris*), dickcissel (*Spiza americana*), red-winged blackbird (*Agelaius phoeniceus*), Eastern meadowlark (*Sturnella magna*), brown-headed cowbird (*Molothrus ater*), scissor-tailed flycatcher (*Muscivora forfic*), and American robin (*Turdus migratorius*) (USACE 2003a).

4.4.5.4 Mammals

A variety of small mammals, bats, carnivores/omnivores, and ungulates occur at Lake Texoma, including the thirteen-lined ground squirrel (*Spermophilus tridecemlineatus*), opossum (*Didelphis marsupialis*), least shrew (*Cryptotis parva*), eastern harvest mouse (*Reithrodontomys humulis*), deer mouse (*Peromyscus maniculatus*), eastern cottontail (*Sylvilagus floridanus*), red bat (*Lasiurus borealis*), evening bat (*Nycticeius humeralis*), striped skunk (*Mephitis mephitis*), coyote (*Canis latrans*), bobcat (*Lynx rufus*), red fox (*Vulpes fulva*), raccoon (*Procyon lotor*), and white-tailed deer (*Odocoileus virginianus*) (USACE 2003a).

4.4.6 Threatened and Endangered Species

Consultation was initiated in July 2003 (USACE 2003b) with the U.S. Fish and Wildlife Service (Service) regarding listed species with the potential to be affected by USACE activities on the Arkansas, Canadian, and Red Rivers in Arkansas, Oklahoma, and Texas; and on the McClellan-Kerr Arkansas River Navigation System in Arkansas and Oklahoma. A Biological Assessment (BA) was prepared by the USACE and submitted to the Service (USACE 2003b) as part of this consultation. In June 2005 the Service issued a Biological Opinion (BO) to the Corps that included the operation of Denison Dam. The BO is incorporated by reference in this EA.

The USACE narrowed the list of 16 species provided by the Service for the consultation down to seven species with the potential to occur at Lake Texoma or in the Red River System below Denison Dam. Table 12 provides the list of these species and their status.

Table 12. Threatened and Endangered Species with the Potential to Occur at Lake Texoma or in the Red River System Below Denison Dam.

Common Name	Scientific Name	Status: (T) Threatened, (E) Endangered
Bald eagle	*Haliaeetus leucocephalus*	T
Interior least tern	*Sterna antillarum*	E
Whooping crane	*Grus americana*	E
Piping plover	*Charadrius melodius*	T
American alligator	*Alligator mississippiensis*	T
Scaleshell mussel	*Leptodea leptodon*	E
American burying beetle	*Nicrophorus americanus*	E

The bald eagle and interior least tern are known to occur in the project area. Bald eagles are common winter residents along the shores of Lake Texoma and are also known to nest in this area (USACE 2003b). They use tall trees near water for foraging, roosting, and nesting, and are also known to nest in cliffs. Downstream of Lake Texoma, interior least terns are common summer residents and utilize sandbar habitats for nesting and loafing and the adjacent shallow water habitat for feeding. Least terns are addressed at length in the BO and are the listed species most visible along the Red River.

The whooping crane and piping plover are considered migrants in the vicinity of Lake Texoma. Whooping cranes, which are considered rare spring and fall migrants in this area, use emergent vegetation along the edges of marshes, prairie pothole wetlands, or lakes for resting sites; croplands for foraging; and riverine wetlands for roosting. While it is possible that whooping cranes use the available habitat at Lake Texoma and along the Red River below Denison Dam, historical records indicate that they primarily use the habitat along the river upstream of the lake. Lake Texoma is located in the migration corridor of the piping plover, and it is possible that this species uses mudflats associated with the Red River in the vicinity of Lake Texoma. However, there are no records of locations used frequently by this species for the project area. (USACE 2003b).

The American alligator uses rivers, swamps, lakes, and marshes, digging dens in riverbanks or shorelines of lakes. Although this species is considered a possible transient in the lower portion of the Red River, it does not appear to be found near Lake Texoma (USACE 2003b).

The scaleshell mussel is found in larger creeks and small to medium size rivers with good water quality, in riffles with moderate to high gradients. In Oklahoma, recent surveys in the Red River basin failed to find this species. Although habitat for this species is likely to be supported in the project area, it does not appear that the scaleshell mussel is found near Lake Texoma (USACE 2003b).

The American burying beetle is known to occur in several counties along or near Lake Texoma. Little is known about the habitat requirements of this species, however, in Oklahoma, it has been found in habitats ranging from deciduous and coniferous forests to open pasture. Surveys for the

American burying beetle have been conducted on the Washita River Arm of Lake Texoma, but have not resulted in collection of this species (USACE 2003b). Since it is known to occur in the vicinity of the lake, and because it is a highly mobile species, it could occur in suitable habitat at Lake Texoma.

4.5 Cultural Resources

In accordance with Section 106 of the National Historic Preservation Act of 1966 (as amended), the appropriate agencies and Native American tribes were contacted via written correspondence (dated February 15, 2001) to discuss potential impacts on cultural resources. The Tulsa District mailed letters to the Oklahoma Historical Society State Historic Preservation Office, the Oklahoma Archeological Survey, and the Texas Historical Commission, as well as the Wichita and Affiliated Tribes of Oklahoma, the Choctaw Nation of Oklahoma, the Chickasaw Nation of Oklahoma, and the Caddo Indian Tribe of Oklahoma (Appendix C). In these letters, the Tulsa District established the position that there would be “no effect” on cultural resources as a result of the Lake Texoma storage reallocation project.

The Oklahoma Historical Society responded on March 6, 2001, indicating that this project is not subject to consultation requirements because there would be no construction or earth-moving activities. The Oklahoma Archeological Survey responded on February 28, 2001, that the project should have no impact on the prehistoric cultural or archeological resources of Oklahoma. Finally, the Texas Historical Commission responded on March 2, 2001, indicating their concurrence with the “no effect” determination and that the project may proceed. Each agency response is documented in Appendix C. None of the tribes contacted have provided comments on the project. Section 106 coordination is therefore complete for this project.

4.6 Air Quality

USEPA published a Conformity Rule on November 30, 1993, requiring all Federal actions to conform to appropriate State Implementation Plans (SIPs) that were established to improve ambient air quality. National Ambient Air Quality Standards exist for six pollutants: carbon monoxide, ozone, respirable particulate matter (including particulates equal to or less than 10 microns in diameter [PM_{10}] and particulate matter equal to or less than 2.5 microns in diameter [$PM_{2.5}$]), sulfur dioxide, nitrogen oxides, and lead). In July 1997, the 8-hour ozone standard was promulgated and the existing 1-hour ozone standard was remanded for all areas, except those designated nonattainment with the 1-hour standard when the 8-hour standard was adopted. Implementation of this new standard was delayed due to legal challenges; however, on April 15, 2004, USEPA promulgated the Final Implementation Rule and designated as nonattainment those areas that exceeded the 8-hour ozone standard throughout the country.

These "criteria pollutants" are the only pollutants for which standards have been established. USEPA assigns designations, based on an area's meeting, or "attaining" these standards. At this time, the Conformity Rule only applies to Federal actions in nonattainment areas. A nonattainment area is an area that does not meet one or more of the National Ambient Air Quality Standards for the criteria pollutants designated in the Clean Air Act (CAA).

The project area is within the Oklahoma counties of Love, Bryan, Marshall, and Johnston; and the Texas counties of Grayson and Cooke. According to maps in the USEPA “Green Book” (for criteria pollutant nonattainment areas), all counties within Oklahoma have been designated as attainment areas for criteria pollutants and air toxins, including the 8-hour ozone standard (USEPA 2004) The TCEQ maintains information on SIPs related to air quality in Texas’ nonattainment areas. Grayson and Cooke counties have been designated attainment areas for all criteria pollutants and air toxins, including the 8-hour ozone standard (TNRCC 2002).

A conformity analysis based on air emissions analysis is required for any proposed Federal action within a nonattainment area. Since the geographical region potentially affected by the Lake Texoma storage reallocation project is in attainment and meets the National Ambient Air Quality Standards for the criteria pollutants designated in the CAA, a conformity determination is not required.

4.7 Hazardous, Toxic, and Radiological Wastes

Potential pollution sources in the vicinity of Lake Texoma include sewage disposal/treatment systems (septic tanks and other subsurface disposal systems, as well as municipal sewage treatment plants), private cabins and concession operations, boats, sanitary landfills, open dumps, water treatment plants, animal production facilities, and oil production facilities (USACE 1996a, 2003a).

Of these potential sources, oil production facilities present the greatest threat to Lake Texoma. Several active oil fields are on or surrounding government property, while hundreds of transport pipelines cross government property and surface waters that feed Lake Texoma. To date, none of these sources have had a significant effect on Lake Texoma (USACE 1996a, 2003a).

4.8 Noise

Noise sources at Lake Texoma are primarily affiliated with recreation activities and include motor boats, motor vehicles, hunting, and people at the marinas, campgrounds, and other recreational facilities surrounding the lake. Operation of the hydropower facilities represents another source of noise at the lake.

5 Environmental Impacts of the Proposed Action

According to screening criteria described in Section 2.2, only one action alternative was suitable for further, more detailed evaluation: the proposed action as described in Section 3. A summary of environmental impacts is presented in Table 13 (page 29).

5.1 Socioeconomics

5.1.1 No Action Alternative

5.1.1.1 Population

Under the No Action Alternative, population trends of the past decade would continue. Population dynamics would be influenced by economic and recreational opportunities in the counties surrounding Lake Texoma, while the demand for residential lands would continue to be linked to future population dynamics. The 150,000 acre-feet of water currently in water supply would continue to be available to help service current and future populations of southern Oklahoma and northern Texas.

5.1.1.2 Employment and Income

The employment rate in the social area would remain similar to the state levels for both Oklahoma and Texas. The educational, health, and social services; manufacturing; and retail trade sectors would be expected to continue as an important part of the economy in this area. Recreational services and oil and gas exploration would be expected to increase in their importance for the local economy. With respect to water supply from Lake Texoma, municipal, industrial, and agricultural opportunities would continue to be limited to the 150,000 acre-feet of water currently available in water supply storage at Lake Texoma.

Income in the defined social area would continue to be near or below the state averages. The current allocation of water supply storage at Lake Texoma would not be expected to influence income in the counties surrounding Lake Texoma.

5.1.1.3 Social Ecology

The area would continue to be primarily a mix of residential, agricultural lands, and business. Demand for new residential developments would increase the transition of agricultural lands into residential areas. The area would continue to be a center for recreation.

5.1.2 Proposed Action

5.1.2.1 Population

Reallocation of 300,000 acre-feet from hydropower to water supply storage could have an effect on the population of the social area. Although it would not directly affect overall population growth trends in southern Oklahoma and northern Texas, this additional water supply would be available for new industrial, agricultural, and municipal users in this area. This could promote growth of business-related opportunities and residential development in the social area, which could cause small, local changes in population.

5.1.2.2 Employment and Income

The employment rate in the social area would continue to remain similar to the state levels for both Oklahoma and Texas. Some new job opportunities might become available associated with new opportunities from the additional water supply storage. These would likely be in the residential development (e.g., construction), recreation (e.g., golf courses), retail (e.g., restaurants), agricultural, and oil and gas industries.

The educational, health, and social services; manufacturing; and retail trade sectors are expected to continue to be an important part of the economy in this area. New business opportunities in the social area would not appreciably affect income because they would be similar to existing enterprises (e.g., construction, recreation, retail, agricultural, and oil and gas).

5.1.2.3 Social Ecology

The reallocation of hydropower storage to water supply storage would reinforce the social ecology of this area as primarily a mix of residential, agricultural, and business. Increased demand for new residential developments could increase the transition of agricultural lands into residential areas. The area would continue to be a center for recreation.

5.2 Natural Resource Impacts

5.2.1 No Action Alternative

Under the No Action Alternative, conditions at Lake Texoma would remain status quo. There would be no impacts on terrestrial resources, soils, and prime farmland; hydrology; fish and wildlife; or threatened or endangered species.

Table 13. Impact Assessment Matrix

Name of Parameter	Magnitude of Probable Impact						
	Increasing Beneficial Impact			No Appreciable Effect	Increasing Adverse Impact		
	Significant	Substantial	Minor		Minor	Substantial	Significant
SOCIAL EFFECTS							
Noise Levels				X			
Aesthetic Values				X			
Recreational Opportunities				X			
Transportation				X			
Public Health and Safety			X				
Community Cohesion (Sense of Unity)				X			
Community Growth and Development			X				
Business and Home Relocations			X				
Existing/Potential Land Use			X				
Controversy				X			
ECONOMIC EFFECTS							
Property Values				X			
Tax Revenues				X			
Public Facilities and Services			X				
Regional Growth			X				
Employment			X				
Business Activity			X				
Farmland/Food Supply			X				
Flooding Effects				X			
Hydropower				X			

able 13. Impact Assessment Matrix (cont'd)

Name of Parameter	Magnitude of Probable Impact						
	Increasing Beneficial Impact			No Appreciable Effect	Increasing Adverse Impact		
	Significant	Substantial	Minor		Minor	Substantial	Significant
NATURAL RESOURCE EFFECTS							
Air Quality				X			
Terrestrial Habitat				X			
Wetlands					X		
Aquatic Habitat					X		
Habitat Diversity and Interspersion				X			
Biological Productivity					X		
Surface Water Quality				X			
Water Supply		X					
Groundwater				X			
Soils				X			
Threatened and Endangered Species				X			
CULTURAL RESOURCES							
Historic Architectural Values				X			
Prehistoric & Historic Archeological Values				X			

5.2.2 Proposed Action

5.2.2.1 Terrestrial

Construction and earth-moving activities would not be directly associated with the storage reallocation project at Lake Texoma. Reductions in elevation duration, elevation frequency, discharge duration, and discharge frequency (see Section 5.2.2.3, Hydrology) would not be expected to have effects on terrestrial resources such as upland plant communities. Because the Proposed Action does not involve raising lake levels, there is no concern for additional flooding or backwater effects that would have an impact on terrestrial resources upstream of Lake Texoma.

5.2.2.2 Soils and Prime Farmland

Although soils classified as prime farmland do exist in the project area, there would be no direct effects from the storage reallocation at Lake Texoma. None of these soils would be converted to different uses (i.e., taken out of agricultural production), nor would they be affected by the reductions in elevation duration, elevation frequency, discharge duration, or discharge frequency.

5.2.2.3 Hydrology

Reallocation of storage in Lake Texoma would result in negligible changes to elevation duration, elevation frequency, discharge duration, or discharge frequency at Lake Texoma. Using data from the period of record (1938 to 2000), model outputs for the Proposed Action (see Appendix B) indicate that elevation frequency, or the percent of years in which a given lake elevation is equaled or exceeded, would not change perceptibly (reduced by less than 1 percent) with implementation of the Proposed Action (see Figure 2 in Appendix B). All model outputs reflect actual drought and flood periods within the period of record. These models also indicate that elevation duration, or the percent of time for which a given lake elevation is exceeded, would not change perceptibly (reduced by less than 1 percent) when lake elevations are approximately 617 feet above MSL or higher (see Figure 3 in Appendix B). Below this elevation, elevation duration would decrease by approximately 3 to 8 percent under the Proposed Action. For example, under current conditions, elevations of approximately 613 feet are exceeded approximately 85 percent of the time; under the Proposed Action, this elevation would be exceeded approximately 80 percent of the time.

These changes will reduce the amount of water available in hydropower storage and ultimately the water available for generation. In addition, reallocating 300,000 acre-feet from hydropower storage would reduce water available to the hydropower pool by approximately 23 percent, from 1,317,283 acre-feet to 1,017,283 acre-feet. The water lost as a result of reallocation from hydropower to water supply storage would no longer be available to run through the turbines of the hydropower operation, and would represent a reduction in downstream discharges. Based on the results of the modeling, however, discharge frequency, or the percent of years in which a given discharge would be equaled or exceeded, would not change perceptibly (reduced by approximately 1 to 2 percent) for discharges above 3,500 cfs (see Figure 4 in Appendix B). The frequency of discharges below this rate would be reduced slightly further, but not by more than 5 percent, with implementation of the Proposed Action. The model results also show that discharge duration, or the percent of time for which a given discharge would be equaled or exceeded, would also be only slightly reduced. This change would be the most pronounced for discharges between 600 and 7,000 cfs, where discharge duration would be reduced by approximately 3 to 8 percent under the Proposed Action (see Figure 5 in Appendix B). For example, under current conditions, discharges of 2,000 cfs are equaled or exceeded approximately 52 percent of the time. Under the Proposed Action, these discharges would be equaled or exceeded approximately 45 percent of the time. Outside of this 600 to 7,000 cfs range, changes in discharge duration are imperceptible (reduced by approximately 2 percent or less). The changes seen in this lower range of discharges reflect changes in hydropower generation due to the reduction in storage available to hydropower. This will be slightly more pronounced during dry times.

In addition, modeling of discharge duration and frequency at Arthur City, Texas, approximately 95 miles downstream of Lake Texoma, indicates that the effects of the Proposed Action are reduced the further one travels below the lake. According to the model results, there would be imperceptible changes in discharge frequency (see Figure 6 in Appendix B) and discharge duration would be reduced by less than 5 percent (see Figure 7 in Appendix B).

Elevation duration and elevation frequency would be affected less than 1 percent above 617 feet above MSL. Below that elevation, elevation duration would decrease approximately 3 to 8 percent under the proposed action. The 3 to 8 percent reduction is in percent of time that the pool elevation would be equaled or exceeded or a specific flow is equaled or exceeded. The slight reduction in elevation duration at Lake Texoma below elevation 617 feet above MSL would have only minor and insignificant adverse affects on aquatic or wetland habitat. It could result in the creation of mudflats and emergent wetlands during drought years in areas that were previously lacustrine. Backwater effects (e.g., flooding) on aquatic and wetland habitat at and upstream of the lake are not anticipated.

The reduction in discharge duration and frequency could affect aquatic and wetland habitat downstream of Lake Texoma and Denison Dam (e.g., pools along the Red River that provide aquatic habitat could be shallower at times, and wetlands dependent on periodic inundation might receive less water as a result of lower flows). However, as the model results for Arthur City indicate, the effects would be reduced as one travels further downstream from the lake. Additionally, regulation of flows on the Red River is an authorized project purpose at Lake Texoma. Low-flow releases, in combination with normal discharges for hydropower generation, generally ensure that some water passes through the aquatic and wetland habitat of the Red River downstream of Lake Texoma. Finally, during drought conditions, drought contingency plans would be implemented (see Section 6.0, Relevant Operational Plans) to ensure that adequate water is available for conservation purposes, including downstream discharges to maintain minimum water flows in the Red River, which in turn support aquatic habitat and wetlands.

Because the Proposed Action does not involve raising lake levels, there is no concern for additional flooding or backwater effects that would have an impact on aquatic and wetland habitat upstream of Lake Texoma.

Although water supply could come from a slightly lower level in the lake when compared to current withdrawals, this would not have an appreciable effect on water quality at Lake Texoma. Effects on thermal gradients, as well as chemical water quality parameters (e.g., total dissolved solids, dissolved oxygen), are not anticipated, and would be imperceptible if they did occur. The reductions in discharge duration and frequency could adversely affect dissolved oxygen levels just downstream of Lake Texoma. However, low-flow releases and discharges for hydropower generation would help maintain dissolved oxygen, as well as reduce periods of no flow and stagnation even further downstream in the Red River. The Proposed Action would not change the potential for erosion and sedimentation at Lake Texoma or in the Red River. Overall, water quality would not be affected in the lake or the Red River, and the Proposed Action would not affect the designation of 303(d) waters or the development of TMDLs in the states of Oklahoma or Texas.

No wetland or water quality permits would be required for implementation of the Proposed Action (see Appendix D).

5.2.2.4 Fish and Wildlife

Construction and earth-moving activities are not necessary to implement the storage reallocation project at Lake Texoma, and upland wildlife habitat and species would be unaffected. Reductions in elevation duration, elevation frequency, discharge duration, and discharge frequency (as discussed in Section 5.2.2.3, Hydrology) could have impacts on wildlife that use the aquatic and wetland habitat available in the lake and the Red River. A reduction in elevation duration and frequency at the lake could result in the formation of new wetlands, which would provide important wildlife habitat (especially for fish and amphibians) in areas that were previously inundated. Although this could result in the loss of shoreline aquatic habitat for wading birds/waterfowl, fish, and amphibians, the effects would be imperceptible given the extent of this habitat at Lake Texoma. In addition, the implementation of seasonal pool plans that benefit wildlife would continue to cause periodic inundation of these areas, temporarily restoring such habitat. Therefore, the Proposed Action is not anticipated to significantly affect wildlife or their habitat at the lake.

Under the Proposed Action, reductions in discharge duration and frequency from the lake are not expected to significantly affect wildlife or their habitat downstream of Lake Texoma. These reductions could, at times, cause pools that provide habitat for fish along the Red River to be shallower; however, impacts would be negligible. Wetlands dependent on periodic inundation might receive less water as a result of lower flows. However, the effect diminishes as one travels further from the lake, as indicated in the modeling results for Arthur City, Texas discussed in Section 5.2.2.3. In addition, low-flow releases and discharges for hydropower generation would ensure that some water passes through the aquatic and wetland habitat of the Red River downstream of Lake Texoma.

Because the Proposed Action does not involve raising lake levels, there is no concern for additional flooding or backwater effects that would have an impact on wildlife upstream of Lake Texoma.

5.2.2.5 Threatened and Endangered Species

Reductions in discharge duration and frequency are not anticipated to significantly affect the hydrologic conditions that create sandbar habitats used by interior least terns downstream of Lake Texoma. In addition, modified releases from the dam are made to enhance or maintain interior least tern habitat, and would continue under the Proposed Action as necessary (USACE 2002). Because there would be no construction-related activities that could impact interior least terns (e.g., heavy equipment noise or habitat loss) and because potential changes to downstream discharges would have minimal impacts, the Proposed Action would have no effect on interior least terns downstream of Lake Texoma. This action is covered in the comprehensive biological opinion (BO) issued by the U.S. Fish and Wildlife Service in June of 2005.

Reductions in elevation duration and frequency at Lake Texoma would not result in the loss of shoreline habitat (e.g., large trees near the water) that supports bald eagles. In addition, there would be no direct construction-related activities that could impact bald eagles (e.g., noise from heavy-equipment or tree removal). There would be no changes in water quality that could affect the prey base of the bald eagle under this alternative. Therefore, the Proposed Action would have no effect on bald eagles at Lake Texoma.

Although habitat for the whooping crane and piping plover is supported in the project area, historical records indicate that they occur primarily as migrants in the vicinity of Lake Texoma. Regardless, reductions in discharge duration and frequency are not anticipated to significantly affect the hydrologic conditions that create the wetland and mudflat areas downstream of the lake that may be used by these species. The modified releases for least tern management would also ensure that the hydrology downstream of Lake Texoma is maintained, as necessary. Reductions in elevation duration and frequency at Lake Texoma would not significantly affect the shoreline habitat that may be used by whooping cranes. In fact, a reduction in elevation duration and frequency at the lake could result in the formation of new wetlands, which could provide additional rest areas for whooping cranes. Because there would be no construction-related activities that could impact whooping cranes and piping plovers (e.g., heavy equipment noise or habitat loss), because potential changes to discharge or elevation duration and frequency would have no impact on their habitat, and because there would be no changes in water quality that could affect the prey base of either species, the Proposed Action would have no effect on these species.

Impacts on the American alligator and scaleshell mussel are not anticipated under the Proposed Action, as these species are not likely to occur in the project area. In addition, changes in discharge or elevation duration and frequency at Lake Texoma are not anticipated to alter the potential habitat for these species. There would be no changes in water quality that could affect the prey base of these species under this alternative. Therefore, the Proposed Action would have no effect on the American alligator or scaleshell mussel.

Although the American burying beetle has the potential to occur at Lake Texoma, the Proposed Action would not affect the terrestrial environment in which this species is supported (upland plant communities). Therefore, the Proposed Action is not anticipated to have significant effects on this species.

Because the Proposed Action does not involve raising lake levels, there is no concern for additional flooding or backwater effects that would have an impact on threatened or endangered species that might occur upstream of Lake Texoma.

In a letter dated October 5, 2004 (Appendix A), the Service concurred with these determinations, indicating that they do not anticipate any federally-listed species to be adversely affected by the proposed storage reallocation. They stated that the Proposed Action was covered in the USACE BA (USACE 2003b) and that compliance with Section 7 of the Endangered Species Act has been addressed in the subsequent biological opinion issued by the Service.

5.3 Cultural Resources

5.3.1 No Action Alternative

Under the No Action Alternative, there would be no impact on cultural resources.

5.3.2 Proposed Action

As outlined in Section 4.5, Section 106 coordination under the National Historic Preservation Act is complete; no impacts on cultural resources are expected as a result of the Proposed Action. Refer to Appendix C for cultural resources coordination.

5.4 Air Quality

5.4.1 No Action Alternative

Under the No Action Alternative, conditions at Lake Texoma would remain status quo. There would be no impact on air quality.

5.4.2 Proposed Action

The Proposed Action would not result in any direct effects on air quality.

5.5 Hazardous, Toxic, and Radiological Wastes

5.5.1 No Action Alternative

Under the No Action Alternative, conditions at Lake Texoma would remain status quo. There would be no impacts on hazardous, toxic, and radiological wastes.

5.5.2 Proposed Action

The proposed storage reallocation at Lake Texoma would not result in any effects on hazardous, toxic, and radiological wastes in the project area.

5.6 Noise

5.6.1 No Action Alternative

Under the No Action Alternative, conditions at Lake Texoma would remain status quo. There would be no impacts on the noise environment.

5.6.2 Proposed Action

The proposed storage reallocation at Lake Texoma would not result in any effects on noise in the project area.

5.7 Indirect and Cumulative Impacts

Indirect and cumulative impacts associated with the proposed action could include localized areas of soil disturbance and related impacts associated with future construction of water intake structures and similar facilities for water supply users around Lake Texoma. If Federal funds are involved in the construction of intake structures or related facilities, NEPA documentation will be prepared at that time. In addition, alternate energy sources to hydropower generation, if required, could result in increased emissions of air pollutants in areas where these sources are employed. While uncertainties regarding numbers, location, and design of these structures preclude detailed impact analyses, implementation of these features would be subject to appropriate permitting requirements and compliance with all applicable environmental laws and regulations for their construction and operation. This should ensure that an appropriate level of environmental protection accompanies future development of these features.

6 Relevant Operational Plans

Regulation of flows on the Red River is an authorized project purpose at Lake Texoma. Normally, low-flow and hydropower releases are made through the turbines. In the late summer, dissolved oxygen levels can become too low to support certain species of fish. If dissolved oxygen monitoring indicates that levels are at a critical point, a low flow release of 50 cfs is discharged through one of the flood-control conduits. Water released in this manner becomes highly aerated, and has proven effective in maintaining dissolved oxygen levels to prevent fish kills (USACE 1993b).

During drought conditions, a Drought Contingency Plan is implemented at Lake Texoma (USACE 1993b). This plan is designed to provide coordination and intensify actions as drought increases in severity, with four levels of response to be progressively initiated as the drought intensifies. This plan ensures that all of the project purposes, including flood control, water supply, hydroelectric power, downstream flow regulation, improvement to navigation, and recreation, are not compromised during drought conditions.

A Biological Opinion (BO) was issued by the U. S. Fish and Wildlife Service (Service) by letter dated June 28, 2005 that placed specific requirements on the U. S. Army Corps of Engineers pertinent to endangered species and the operation of Denison Dam and its affects on the Red River downstream to Index, Arkansas. Specifically the BO placed requirements on the Corps for flood control releases, hydropower releases, low flow releases, and lake level manipulation to address needs of the interior population of the least tern which nests in good numbers on the Red River below Denison Dam. The BO requires the Corps to coordinate frequently and in a timely manner with the Service when it has determined that increased flow releases may flood terns (flood releases) or decreased flows may land-bridge tern nesting sites. During these flood events or low flow events, the Corps must provide to the Service for discussion, its recommendations to reduce flooding or land-bridging of nests. The Service requires that the maintenance of least tern nesting habitat shall be a priority of the Corps and operational activities modified and implemented to meet or exceed tern reproductive requirements established by the Service.

Different types of releases for interior least tern management are made during the nesting season as opposed to the non-nesting season. While lake levels are maintained for implementation of the Seasonal Pool Plan, hydropower generation, and flood control, minimum-flow releases are made throughout the nesting season (June and into or through August) to protect interior least tern nesting sites. During the 2001 nesting season, the average flow requirement to protect interior least terns below Lake Texoma was 5,000 cfs. There is no contractual storage for water released to comply with Service requirements so this water will be equally proportioned from all users.

7 Federal, State, and Local Agency Coordination

The draft EA was coordinated with the following agencies having legislative and administrative responsibilities for environmental protection. Copies of the correspondence from those agencies that provided comments and planning assistance for preparation of the draft EA are in the appendices. The mailing list for the 30-day public review period for this EA is in Appendix A.

U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service
U.S. Department of Agriculture
Oklahoma Water Resources Board
Oklahoma Department of Environmental Quality
Oklahoma Department of Wildlife Conservation
Oklahoma Historical Society State Historic Preservation Office
Oklahoma Archeological Survey
Texas Water Development Board
Texas Parks and Wildlife Department
Texas Commission on Environmental Quality

Red River Authority
Texas Historical Commission
Wichita and Affiliated Tribes of Oklahoma
Choctaw Nation of Oklahoma
Chickasaw Nation of Oklahoma
Caddo Indian Tribe of Oklahoma
Quapaw Tribe of Oklahoma

8 References

Bailey 1995	Bailey, Robert G. *Description of the Ecoregions of the United States*. Second edition revised and expanded (First edition 1980). Misc. Publ. No. 1391 (rev.), Washington, DC: USDA Forest Service.
NCDC 1998	National Oceanic and Atmospheric Administration, National Climatic Data Center (NCDC). 1998. *Climatic Wind Data for the United States*. November 1998.
NCDC 2002	National Oceanic and Atmospheric Administration, National Climatic Data Center (NCDC). 2002. Divisional Normals and Standard Deviations of Temperature, Precipitation, and Heating and Cooling Degree Days. Climatography of the United States No. 85. June 15, 2002. Available: http://www5.ncdc.noaa.gov/cgi-bin/climatenormals/climatenormals.pl?directive=prod_select2&prodtype=CLIM85&subrnum=. Accessed: September 27, 2004.
OCS 2002	Oklahoma Climatological Survey (OCS). 2002. Oklahoma Climate Data, Normals and Extremes. Copyright 1996–2002, The Oklahoma Climatological Survey. Available <*http://climate.ocs.ou.edu/normals_extremes.html*>. Accessed March 31, 2004.
OKDEQ 2002	Oklahoma Department of Environmental Quality (OKDEQ). 2002. *The State of Oklahoma 2002 Water Quality Assessment Integrated Report Prepared Pursuant to Section 303(d) and Section 305(b) of the Clean Water Act*. Available <*http://www.deq.state.ok.us/WQDnew/305b_303d/index.html*>. Accessed 2004.
OKDEQ 2003	OKDEQ. 2003. "Integrated Water Quality Assessment, Clean Water Act (CWA) Section 303(d) Requirements." Available <*http://www.deq.state.ok.us/WQDnew/305b_303d/index.html*>. Accessed December 31, 2003.
OKDOC 2004	Oklahoma Department of Commerce (OKDOC). 2004. "Community and County Profiles." Available <*http://busdev3.odoc5.odoc.state.ok.us/servlet/page?_pageid=1291&_dad=portal30&_schema=PORTAL30&cwt=7&cwr=68*>. Accessed April 1, 2004.

ORIGINS 2004	Oklahoma Resources Integration General Information Network System (ORIGINS). 2004. Labor Force, Oklahoma Counties Database Query, Unemployment Rate—July 2004. Available <*http://origins.ou.edu/*>. Accessed September 28, 2004.
TNRCC 2002	Texas Natural Resource Conservation Commission (TNRCC). 2002. *The Texas SIP*. Last updated April 26, 2002. Available <*http://www.tnrcc.state.tx.us/oprd/sips/siptexas.html*>. Accessed: April 9, 2004.
TNRCC 2004	TNRCC. 2004. *Draft 2004 Texas 303(d) List*. January 15, 2004. Available <*www.tnrcc.state.tx.us/water/quality/04twqi/_303d/04_303d.pdf*>. Accessed April 15, 2004.
TWC 2004	Texas Workforce Commission (TWC). 2004. Labor Market Information and Other Data. August 2004. Available: <*http://www.twc.state.tx.us/customers/rpm/pmsub3.html*>. Accessed: September 28, 2004.
TWDB 2003	Texas Water Development Board (TWDB). 2003. *Volumetric Survey of Lake Texoma*. Prepared by the U.S. Army Corps of Engineers, Tulsa District. April 13, 2003.
U.S. Census Bureau 2003	U.S. Census Bureau. 2003. 1990 Census Lookup. September 16, 2003. Available <*http://www.census.gov/main/www/cen1990.html*>. Accessed Match 31, 2004.
U.S. Census Bureau 2004	U.S. Census Bureau. 2004. "Census 2000 Gateway." Created January 25, 2002. Revised March 9, 2004. Available <*http://www.census.gov/main/www/cen2000.html*>. Accessed March 31, 2004.
USACE 1989	U.S. Army Corps of Engineers (USACE). 1989. *Denison Dam – Lake Texoma Restudy, Oklahoma and Texas, Draft Feasibility Report and Environmental Impact Statement*. Prepared by the USACE, Tulsa District. December 1989.
USACE 1993a	USACE. 1993. *Lake Texoma, Red River, Oklahoma and Texas Water Control Manual*. Prepared by the USACE, Tulsa District. April 1993.
USACE 1993b	USACE. 1993. *Upper Red River, Oklahoma and Texas, Red River Basin, Waurika Lake and Lake Texoma Drought Contingency Plan*. Prepared by the USACE, Tulsa District. February 1993.
USACE 1996a	USACE. 1996. Tulsa District Lake Texoma Pertinent Data. Document: August 9, 1996. Data: September 1993. Available <*www.swt.usace.army.mil/projects/pertdata/laketexoma/laketexoma.htm*>. Accessed December 5, 2003.
USACE 1996b	USACE. 1996. *Lake Texoma-Denison Dam, Red River, Oklahoma and Texas Shoreline Management Plan to Design Memorandum No. 3C, Master Plan (Updated)*. Prepared by the USACE, Tulsa District.

USACE 2002 USACE. 2002. *Management Guidelines and Strategies for Interior Least Terns*. Prepared by the USACE, Tulsa District. July 2002.

USACE 2003a USACE. 2003. *Denison Dam–Lake Texoma, Red River, Texas and Oklahoma Operational Management Plan, FY 2004 thru FY 2008*. Prepared by the USACE, Tulsa District.

USACE 2003b USACE. 2003. *Biological Assessment Addressing Sixteen Federally Listed Threatened or Endangered Species on the Arkansas, Canadian, and Red Rivers; Arkansas, Oklahoma, and Texas; and on the McClellan-Kerr Arkansas River Navigation System, Arkansas and Oklahoma*. Prepared by the USACE, Tulsa and Little Rock Districts. Submitted to the U.S. Fish and Wildlife Service. November 30, 2003.

USDA 1977 U.S. Department of Agriculture (USDA). 1977. *Soil Survey of Johnston County, Oklahoma*. Prepared by USDA in cooperation with the Oklahoma Agricultural Experiment Station. October 1977.

USDA 1978a USDA. 1978. *Soil Survey of Bryan County, Oklahoma*. Prepared by USDA in cooperation with the Oklahoma Agricultural Experiment Station. September 1978.

USDA 1978b USDA. 1978. *Soil Survey of Love County, Oklahoma*. Prepared by USDA in cooperation with the Oklahoma Agricultural Experiment Station. June 1978.

USDA 1979 USDA. 1979. *Soil Survey of Cooke County, Texas*. Prepared by USDA in cooperation with the Texas Agricultural Experiment Station. May 1979.

USDA 1980a USDA. 1980. *Soil Survey of Marshall County, Oklahoma*. Prepared by the USDA in cooperation with the Oklahoma Agricultural Experiment Station. April 1980.

USDA 1980b USDA. 1980. *Soil Survey of Grayson County, Texas*. Prepared by USDA in cooperation with the Texas Agricultural Experiment Station. February 1980.

USDA 2000a USDA. 2000. *Marshall County, Oklahoma Prime Farmland*. From the electronic Field Office Technical Guide (eFOTG), Section II, Cropland Interpretations. Available <*www.nrcs.usda.gov*>. Accessed April 20, 2004.

USDA 2000b USDA. 2000. *Johnston County, Oklahoma Prime Farmland*. From the electronic Field Office Technical Guide (eFOTG), Section II, Cropland Interpretations. Available <*www.nrcs.usda.gov*>. Accessed April 20, 2004.

USDA 2000c USDA. 2000. *Bryan County, Oklahoma Prime Farmland*. From the electronic Field Office Technical Guide (eFOTG), Section II, Cropland Interpretations. Available <*www.nrcs.usda.gov*>. Accessed April 20, 2004.

USDA 2001 — USDA. 2001. *Cooke County, Texas Prime Farmland List*. From the National Soil Information System. October 18, 2001. Available <www.nrcs.usda.gov>. Accessed: April 21, 2004.

USDA 2002 — USDA. 2002. *Grayson County, Texas Prime Farmland List*. From the National Soil Information System. Export Date: August 29, 2002. Available <*www.nrcs.usda.gov*>. Accessed: April 21, 2004.

USDA 2004 — USDA. 2004. *Love County, Oklahoma Prime Farmland List*. From the National Soil Information System. March 30, 2004. Available <*www.nrcs.usda.gov*>. Accessed: April 20, 2004.

USEPA 2004 — U.S. Environmental Protection Agency (USEPA). 2004. *The Green Book*. January 20, 2004. Available <*http://www.epa.gov/oar/oaqps/greenbk/index.html*>. Accessed April 9, 2004.

USFWS 2000a — U.S. Fish and Wildlife Service (USFWS). 2000. *Draft Tishomingo National Wildlife Refuge Comprehensive Conservation Plan, Tishomingo, Oklahoma*. Prepared for U.S. Fish and Wildlife Service, Region 2. Prepared by Research Management Consultants, Inc. January 2000.

USFWS 2000b — USFWS. 2000. *Draft Hagerman National Wildlife Refuge Comprehensive Conservation Plan, Sherman, Texas*. Prepared for U.S. Fish and Wildlife Service, Region 2. Prepared by Research Management Consultants, Inc. January 2000.

USFWS 2004 — USFWS. 2004. *National Wetlands Inventory—Wetlands Mapper*. Maintained in cooperation with the U.S. Geological Survey. Available <*http://wetlandsfws.er.usgs.gov/*>. Accessed June 3, 2004.

9 Applicable Environmental Laws and Regulations

Table 14. Relationship of Plans to Environmental Protection Statutes and Other Environmental Requirements

Federal Policies	Compliance of Alternatives
Archeological and Historic Preservation Act, 1974, as amended, 16 U.S.C. 469, et seq.	Full compliance
Clean Air Act, as amended, 42 U.S.C. 7609, et seq.	Full compliance
Clean Water Act, 1977, as amended (Federal Water Pollution Control Act, 33 U.S.C. 1251), et seq.	Full compliance
Endangered Species Act, 1973, as amended, 16 U.S.C. 1531, et seq.	Full compliance
Farmland Protection Policy Act, 7 U.S.C. 4201, et seq.	Full compliance
Federal Water Project Recreation Act, as amended, 16 U.S.C. 460-1-12, et seq.	Full compliance
Fish and Wildlife Coordination Act, as amended, 16 U.S.C. 661, et seq.	Full compliance
Land and Water Conservation Fund Act, 1965, as amended, 16 U.S.C. 4601, et seq.	Full compliance
National Historic Preservation Act, 1966, as amended, 16 U.S.C. 470a, et seq.	Full compliance
National Environmental Policy Act, as amended, 42 U.S.C. 4321, et seq.	Full compliance
Native American Graves Protection and Repatriation Act, 1990, 25 U.S.C. 3001-13, et seq.	Full compliance
Rivers and Harbors Act, 33 U.S.C. 401, et seq.	Not applicable
Watershed Protection and Flood Prevention Act, 16 U.S.C. 1001, et seq.	Not applicable
Wild and Scenic Rivers Act, as amended, 16 U.S.C. 1271, et seq.	Not applicable
Water Resources Planning Act, 1965	Not applicable
Water Resources Development Act of 1986 , Public Law 99-662	Full compliance
Environmental Justice (Executive Order 12898)	Full compliance
Floodplain Management (Executive Order 11988)	Full compliance
Protection of Children From Environmental Health Risks and Safety Risks (Executive Order 13045)	Full compliance
Protection of Wetlands (Executive Order 11990)	Full compliance

Note: "Full compliance" means that all requirements have been met of the statutes, Executive Orders, or other environmental requirements for the current stage of planning.

10 List of Preparers

This EA has been prepared under the direction of Mr. Jerry Sturdy and Ms. Jan Hotubbee of the U.S. Army Corps of Engineers, Tulsa District. Individuals from engineering-environmental Management, Inc. (e^2M) who contributed to the preparation of this document are listed below.

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